

Experimentos en el Laboratorio con Repelentes de Tiburones

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Abstracto

Se describen los metodos usados en experimentos hechos en el laboratorio con tiburones vivos, *Mustelus canis* con énfasis en la descripción del procedimiento usado en la colección de los tiburones en Woods Hole, Mass. en el verano; también se describen los métodos de acondicionamiento de los tiburones para trabajos experimentales. Se hicieron ensayos biológicos de la eficacia de varias substancias que inhiben la alimentación de los tiburones.

Some Problems Concerning the Management of the Shrimp Fisheries

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The purpose of this paper is to point out some of the problems encountered in management of the shrimp fisheries. For orientation purposes, a few general statements about shrimp fishing in estuarine waters, and overfishing will be mentioned.

Although natural conditions, such as severe freezes, like the one of January 1940, may cause a sufficient reduction in spawning individuals to affect the crop produced, we have not seen any indication where trawling at sea can do this. Apparently, up to now, fishing becomes unprofitable before the numbers of spawners can be reduced sufficiently to affect the crop produced by these spawners. Consequently, if a depleted level is defined as the point below which there is a direct relation between the number of spawners and the resultant crop, it is not necessary, under present conditions, to fear depletion in the shrimp fishing.

The environmental requirements of different species of shrimp are quite distinct. The white shrimp, *Penaeus setiferus*, is rarely found in depths greater than 35 fathoms, whereas the brown shrimp has been taken at around 100 fathoms. The white, and probably the brown and pink shrimp in the Gulf of Mexico require an estuarine phase early in their lives. On the west coast of Mexico we find that *P. stylirostris* and *P. vannamei* seem to require an estuarine phase, but that *P. californiensis* may not require more than a coastal phase and, perhaps, *P. brevirostris* spends its entire life at sea.

Tagging experiments have shown that there are separate and distinct stocks of white shrimp. It is likely that there are also distinct stocks of pink and brown shrimp. As a consequence, it seems evident that shrimp cannot be treated as a unit when we consider their management. Probably each species and each stock of a species will have to be treated as a separate entity.

Now, let us examine the problem of fishing in estuarine waters. Unless otherwise specifically mentioned, these remarks will pertain only to the white shrimp, since we know more about this species. The white shrimp spawns at sea and the young at an early stage must reach the coastal estuarine waters else they perish. Spawning in Louisiana begins the latter part of March or early in April and continues until about October, with a peak probably in June or July. Although spawning appears to be continuous, the numbers of young entering the fishery as a result of spawning are not continuous.

Young shrimp appear in the estuarine fishing grounds in waves. These are generally three in number. The first two major waves produce the summer and fall estuarine catch and the fall and winter offshore catch. The last wave produces the winter and spring estuarine catch and the spring and summer offshore catch.

When the young first enter estuarine waters they appear to inhabit the peripheral areas, that is the margins of the bays, the marshes, and smaller bayous. In summer, at about two months of age they leave the peripheral zone and move into the larger bodies of estuarine waters and eventually find their way offshore where they spawn at about the age of one year.

It is interesting to speculate on the causes of the waves of young shrimp. The answer to this is not known but the production, or beginning of success, of the second wave can be associated with the movement of the first wave from the peripheral to the central nursery area. The success of the third wave can be associated with the movement of the second wave from the peripheral to central nursery area, together with the movement of the first wave to offshore waters. There is, therefore, a possibility that the shrimp may be its own worst enemy. If this be true then it could be presumed that a certain amount of thinning or fishing on the inland grounds would be beneficial.

There are various problems that arise when we consider thinning on the nursery grounds. Some of these are:

1. Since the first estuarine areas inhabited by young shrimp are peripheral, where the shrimp are not now fished and where they are too small to be of any commercial importance at present, what effect does thinning on the central nursery grounds have on the crop production of the peripheral nursery grounds? In other words can thinning of the population on the central nursery grounds produce more shrimp on the peripheral grounds, thereby leveling off the waves and producing a more continuous supply of shrimp?

2. It is probable that the numbers of shrimp on the central nursery grounds are limited by the food supply available to them. If this is true, then it is also probable that a certain amount of thinning on the nursery grounds would be beneficial in that excess shrimp could be removed from the estuarine areas and still leave a good crop to move offshore. The problem here is to determine what amount of thinning in estuarine waters is beneficial.

3. We are working on a somewhat similar problem in southern Sinaloa and Nayarit on the west coast of Mexico. In this area, for many years, shrimp have been trapped in weirs called *tapos*. In general the *tapos* catch the shrimp as they are moving from one place to another on the nursery grounds. The runs of shrimp are at night and are associated with the low tides occurring near the full and new moons. In studying the *tapo* catch

records we find that interseasonal production may vary as much as 700 per cent. Some of this variation, but by no means all of it, is associated with differences in seasonal rainfall. The interesting point is that in adjacent areas at sea there does not seem to be such large fluctuations in the population of shrimp arriving at sea. It appears that some vast leveling mechanism must be occurring on the nursery grounds, which would indicate that perhaps a certain amount of thinning might be beneficial, or at least some thinning could occur on the nursery grounds without seriously damaging the production at sea.

4. Natural predation, other than cannibalism, seems to be quite important in the estuarine areas. For example, last year we tried to tag shrimp in *tapo* areas to find out where they went at sea. Although we tagged about 5,000 shrimp, not one was caught at sea. Some of the mortality was caused by the small size of the shrimp tagged but apparently much of the mortality could be attributed to predation. The marked shrimp we released were the only shrimp escaping from the *tapos* and there were always countless thousands of catfish and other fish awaiting our tagged specimens even though we would release them at some distance below the *tapos*.

For this reason the use of the shrimp trawls seems preferable because they catch not only the shrimp but also the fishes preying upon the shrimp. Depending upon mortality ratios, it is readily conceivable that a certain amount of trawling in estuarine waters might be beneficial, owing to a reduction in the number of shrimp predators resulting from this trawling.

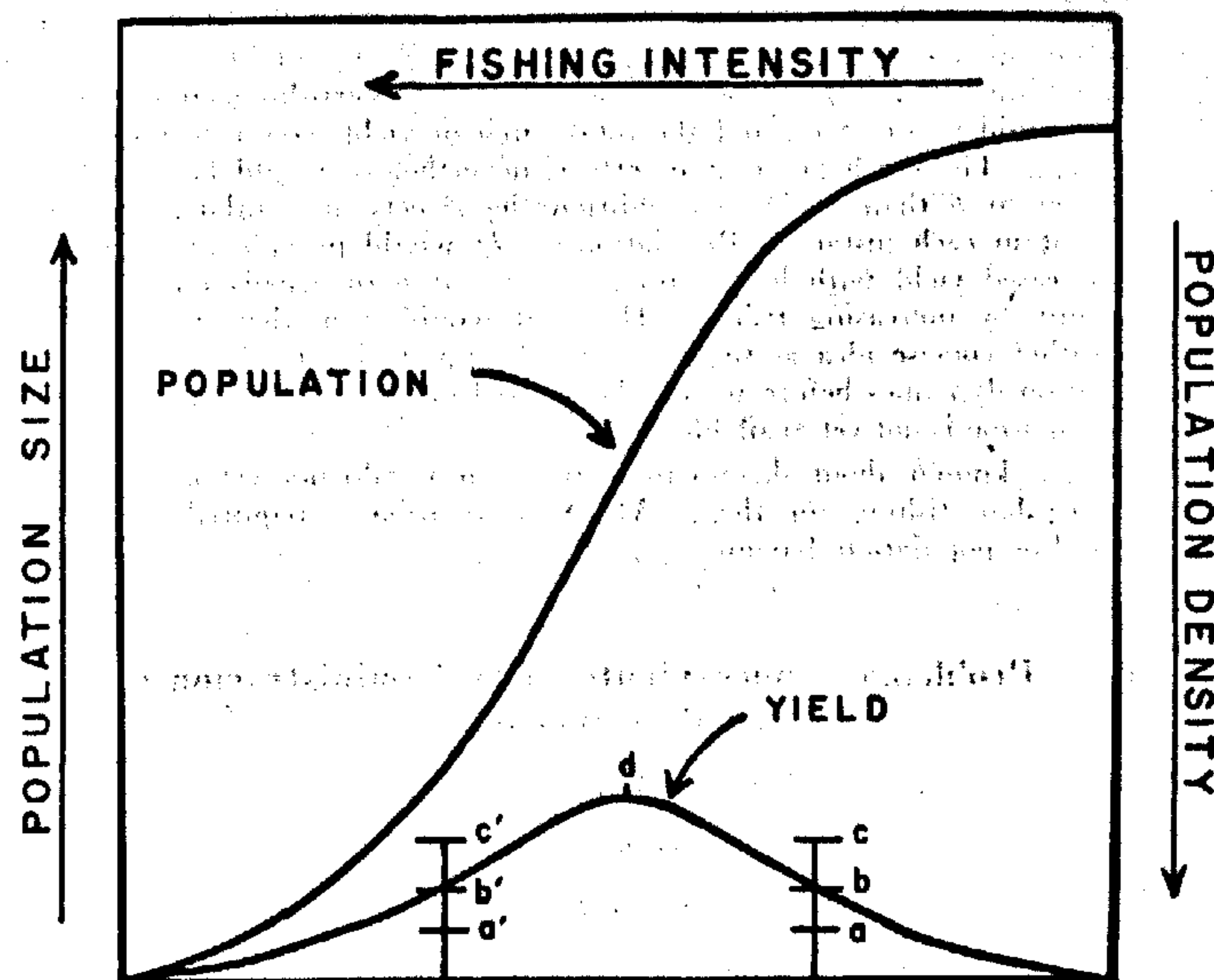
The point made here is that the evidence to date indicates that complete closure of estuarine waters to fishing probably would not be beneficial with respect to shrimp production. On the other hand excessive fishing in estuarine waters can definitely affect the production at sea. The problem is to find out to what extent should fishing in estuarine waters be permitted. Here again we encounter more problems.

In Louisiana, from about the first of April until the end of October growth of shrimp in estuarine waters is extremely rapid, but for about five months of the year, from November through March, there is little or no growth. It is obvious, therefore, that unless there is considerable difference in the magnitude of natural mortality between the rapid growing season and the slow growing season, these two periods must be considered separately with respect to estuarine fishing.

As you can see we do not yet know enough about shrimp to advise what properly should be done with respect to fishing in estuarine waters. It does seem that both complete closure of estuarine waters and excessive fishing in estuarine waters will result in a lesser total poundage of shrimp than if some fishing is permitted.

Since we need not fear depletion, our problem then is that of managing the crop. When we get into this field we find the problems are not purely biological, but also include problems involving sociology, economics and politics. As a consequence we should have a precise idea of our objective. Is it the maximum tonnage of shrimp the crop can produce? Is it greater profits to the industry? Or, is it the maximum number of persons to be employed in the industry? Each of these represents different goals which must be attained by different means.

According to modern fishery theory a fishery develops as the result of com-



plicated interrelations between two sigmoid growth curves, one representing growth of a population of fishes and the other the growth of an industry. The growth of a fishery is limited both by the market for the product and by the size of the fish population. This can be more easily understood if we follow what theoretically happens to a population of fishes being fished as illustrated in the figure. The "S-shaped" curve represents the size of the population of fishes and the "bell-shaped" curve represents the yield or equilibrium catch at any point on the "S-shaped" curve. The "S-shaped" curve is merely a summation of the "bell-shaped" curve. As you can see from the illustration, as fishing effort increases the population density decreases or, in other words, the catch per unit of effort (the catch per boat-day) declines. Also, as fishing effort increases the total yield increases to a maximum (*d* in our illustration) and then decreases as more effort is thrown into the fishery. Furthermore, if the catch is less than the equilibrium yield the population size will increase (*a* and *a'*); if the catch is equal to the equilibrium catch the population will remain constant (*b* and *b'*); and if the catch is greater than the equilibrium catch (*c* and *c'*) the population size will decrease. From this it follows that by fixing or regulating fishing we, theoretically, can regulate the population size and the yield at any point on the curve we may choose. Generally, this is more easily said than done.

With the shrimp, for instance, if we define overfishing as a condition that exists when profits from fishing are less than profits from other industries,

we find that overfishing is highly relative, depending on both the density of shrimp and upon economic conditions. We could, with suitable conditions, have overfishing at any place on our yield curve. Overfishing could occur at b or it could occur at b^1 , and the total catch or yield would be the same in each case. The catch per unit of effort, nevertheless, would be considerably greater at b than at b^1 . In addition the effects of regulation would be different in each instance. Regulations at b^1 would provide for a subsequent increased yield with less fishing, whereas at b the yield could be increased only by increasing fishing. Hence it would seem that we need to have a rather concise idea as to where the shrimp stocks stand with respect to population dynamics before we can be assured of the results of regulation. This information is not yet available.

Enough is known about shrimp to realize that we do not yet know how best to regulate fishing for them. More information is required on their biology and on population dynamics.

Algunos Problemas Concernientes a la Administración de la Pesca de Camarones

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Abstracto

Cada especie de camarón tiene que ser tratada como una entidad separada puesto que todas tienen requisitos distintos. Uno de los problemas es el determinar si la pesca en los criaderos es beneficiosa y produce más camarones en las zonas vecinas. En la costa occidental de Méjico la producción en los criaderos puede variar hasta 700 por ciento de un año a otro. No parece haber esas mismas fluctuaciones en las poblaciones de camarones que arriban en el mar. Se marcaron 5,000 camarones en los criaderos pero no se pescó ni uno de estos en el mar, y aparentemente la mayoría de la mortalidad se debe a peces voraces. Cierta cantidad de arrastres en los criaderos puede ser beneficiosa ayudando a reducir estos peces voraces. La evidencia en esta fecha indica que la clausura de aguas estuarias no sería beneficiosa con respecto a la producción de camarones. Por otro lado se puede decir que la pesca excesiva en aguas estuarias puede afectar definitivamente la producción en el mar.